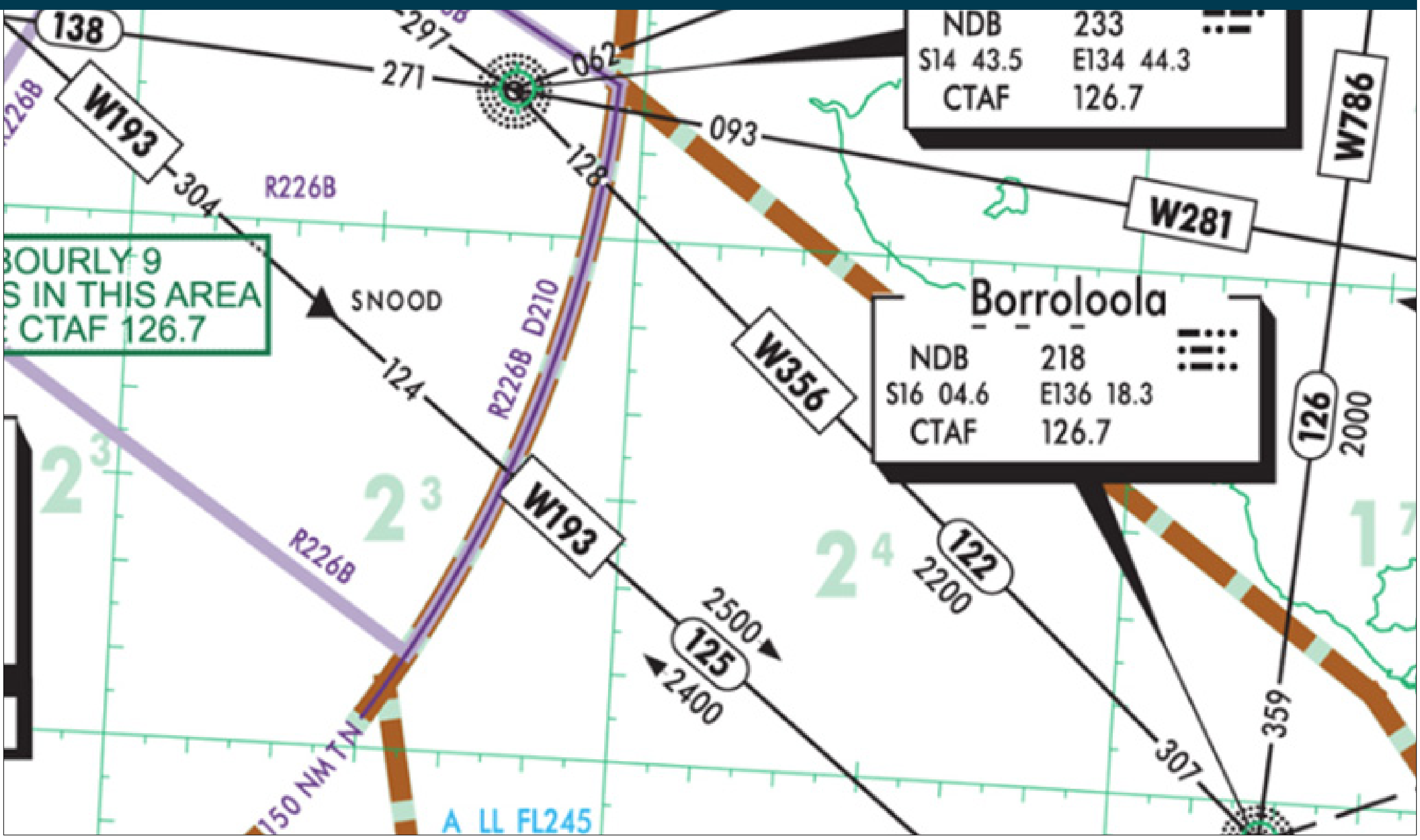
Australian Government
Australian Transport Safety Bureau

Navigation event involving Embraer E170 VH-ANO

232 km north-west of McArthur River Mine, Northern Territory | 10 January 2013



Investigation

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Aviation Occurrence Investigation
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Addendum

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Safety summary

What happened?

On 10 January 2013, the crew of an Embraer Regional Jet 170 (E170), registered VH-ANO and operated by Airnorth, were flying from Darwin to McArthur River Mine, Northern Territory. Shortly after passing navigational waypoint SNOOD, 125 NM (232 km) north-west of McArthur River Mine, the aircraft's flight path started diverging from its planned track. The problem was identified by air traffic control and the crew were advised. The aircraft was re-cleared direct to the initial approach fix and continued to McArthur River Mine.

What the ATSB found

The ATSB found that, while updating the aircraft's flight management system for the descent into McArthur River Mine, the crew unintentionally omitted entering an intended navigational waypoint that was located 25 NM (46 km) north-west of McArthur River Mine. This omission resulted in the aircraft's autopilot tracking the aircraft direct to the initial approach fix instead of first tracking to the intended waypoint. The crew's crosschecking processes were not effective in identifying the data input error.

Although it could not be concluded as contributing to the crew's errors, the ATSB also found that, due to restricted sleep in the previous 24 hours, the crew were probably experiencing a level of fatigue known to have a demonstrated effect on performance. Although the operator's rostering practices were consistent with the existing regulatory requirements, it had limited processes in place to proactively manage its flight crew rosters and ensure that fatigue risk due to restricted sleep was effectively minimised.

What's been done as a result

Airnorth advised that since the occurrence, the number of E170 flight crew has been augmented, increasing its rostering flexibility. Furthermore, due to schedule changes, the operator no longer used any roster pattern that resulted in planned rosters with flight crews receiving less than 10 hours time off duty overnight.

Although not in response to this occurrence, the Civil Aviation Safety Authority has released revised fatigue management and flight and duty time requirements in Civil Aviation Order (CAO) 48.1 Instrument 2013. These new requirements either require operators to have a fatigue risk management system, or operate to more restrictive requirements regarding minimum time off duty than those which previously applied.

Safety message

This occurrence reinforces the importance of all pilots and operators conducting systematic and comprehensive checks of all data entered into flight management systems, and the importance of continually monitoring the effects of data input on an aircraft's flight path.

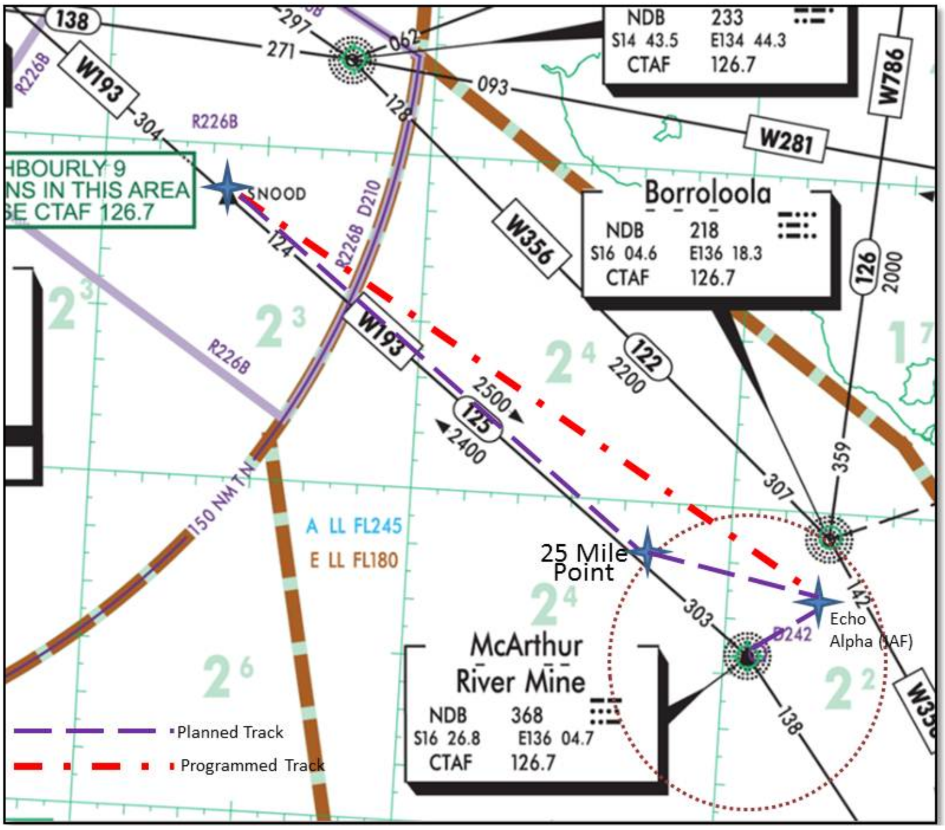
Contents

The occurrence

On 10 January 2013, an Embraer 170 (E170) aircraft, registered VH-ANO and operated by Airnorth, was being flown on a scheduled passenger transport flight from Darwin to McArthur River Mine, Northern Territory. The flight took off on schedule at 0700 Central Standard Time,[1] with the captain as the pilot flying. The flight crew were cleared by air traffic control (ATC) to flight level (FL) 350.[2]

About 125 NM (232 km) north-west of McArthur River Mine, approaching waypoint SNOOD (Figure 1), the captain commenced programming the aircraft's flight management system (FMS) for the descent and landing. The crew's intention was to fly to a crew-initiated waypoint 25 NM (46 km) north-west of McArthur River Mine, then conduct an Area Navigation (RNAV)[3] approach to runway 24, commencing the approach at the initial approach fix MHUEA (labelled 'Echo Alpha (IAF)' in Figure 1). The crew reported they were using runway 24 to avoid landing into the sun. The operator's crews used the 25-NM waypoint as part of a standard procedure to help maintain the aircraft above minimum sector altitudes prior to joining the approach, as well as assisting with air traffic management. Figure 1 illustrates the crew's intended and actual tracks. Figure 2 shows an excerpt from the instrument approach chart.

Figure 1: Intended (purple) and flown (red) tracks into McArthur River Mine (tracks are not to scale)



Source: Airservices Australia (modified by ATSB)

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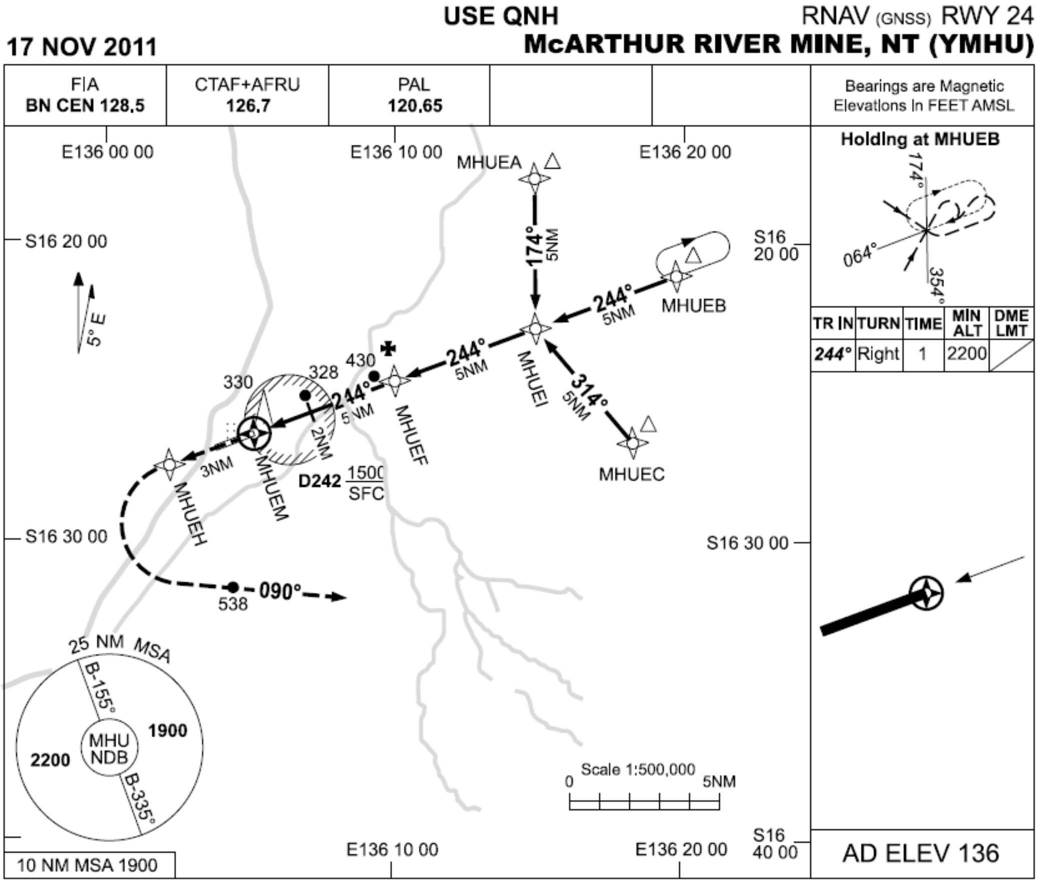
1 Central Standard Time (CST) was Coordinated Universal Time (UTC) + 9.5 hours.

2 At altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 350 equates to 35,000 ft.

3 Area Navigation (RNAV) is a method that permits aircraft navigation along any desired flight path within the coverage of an associated navigation aid. In this case, the associated navigation aid was the Global Navigation Satellite System.

Figure 2: Excerpt from RNAV approach for runway 24 (not for navigation)



Source: Airservices Australia

The captain reported that, when entering the tracking data for the approach into the aircraft's Multifunction Control Display Unit (MCDU),[4] they either did not enter the 25-NM waypoint, or entered the 25-NM waypoint before its later inadvertent deletion.

Both crew carried out a check of the updated FMS flight plan for the approach, which included a visual check of the Navigation Display.[5] As the displayed FMS flight plan was interpreted to be consistent with the crew's intended track to the initial approach fix (IAF), the plan was activated. This set the aircraft up to track from waypoint SNOOD direct to the IAF using the aircraft's automated systems.

After the plan was activated, the crew briefed the approach. This involved reviewing the instrument approach chart and discussing each leg. Both crew recalled that the captain probably started the brief by stating that they were tracking to the IAF instead of initially referring to the 25-NM waypoint. This was a missed opportunity to identify that this waypoint had not been entered into the FMS.

At 0737, the aircraft passed overhead SNOOD. From this point, the autopilot flew the aircraft direct to waypoint MHUEA. This resulted in a track that gradually diverged left of the intended track (Figure 1).

When passing SNOOD, the crew conducted a waypoint check as required by the operator's procedures. This involved the first officer (as pilot monitoring) calling position SNOOD and then the distance and track to the next waypoint on the FMS flight plan. The captain then called 'leg

4 The FMS and crew interaction with the MCDU is described in the subsequent section titled *Flight management system*.

5 The Navigation Display is a moving graphic representation that depicts, among other things, the location of the aircraft relative to the FMS flight plan.

change RNAV check'; however, the navigation data input error and resulting annotation of the IAF as the next waypoint was not detected by the crew. The first officer recalled that they probably did not look at the Navigation Display when they called out the next waypoint.

At 0741, ATC cleared the flight crew to commence their descent to McArthur River Mine via the intended 25-NM waypoint and IAF, and the aircraft started descending soon after. At that time, the aircraft was continuing to diverge laterally from the cleared track.

At about 0748, the aircraft passed through FL 210 and exited ATC radar coverage. Just prior to this time, ATC advised the crew that the aircraft was about 6 NM (11 km) left of the cleared track to McArthur River Mine, and asked whether they were diverting due to weather. In response, the crew performed a check of their flight deck displays, but did not identify any error with their navigation.

Soon after passing FL 180, the flight crew noticed that the aircraft's automatic direction finder[6] was indicating that the aircraft had diverged about 10° to the left of the intended track. After further analysis, the crew identified the FMS flight plan programming error and notified ATC of the situation. ATC approved the crew's request to track direct to the IAF and advised the crew that there was no conflicting traffic. The crew continued the flight to join the RNAV approach.

6 See the following section titled *Other navigation aids*.

Context

Pilot Information

Captain

The captain held an Air Transport Pilot (Aeroplane) Licence and had accumulated about 10,800 flight hours, of which 2,500 hours where on the E170.They had been flying the E170 for about 3 years, including 2 years as captain. The captain was familiar with the route from Darwin to McArthur River Mine, and undertook this service at a rate of about three flights per month.

On the day of the occurrence (10 January 2013), the crew were rostered on a split shift. This entailed a morning duty period commencing at 0600 and ending at 0952, followed by an afternoon duty period from 1712 to 2024. During 7 to 9 January the captain conducted three afternoon-evening duty periods, accumulating 16.4 hours duty time and 10.1 hours flight time. The duty period on 9 January was from 1315 to 2047, resulting in just over 9 hours time free of duty prior to the 0600 start on 10 January. The captain did not conduct any duty from 3 to 6 January.

The captain reported having 5 hours sleep during the night before the occurrence. They had not fully adjusted to the afternoon-evening shifts, and reported that the quality of sleep that night and on previous nights had not been good. The captain noted that both the flight crew were tired and consequently they approached tasks in a steady manner.

First officer

The first officer held an Air Transport Pilot (Aeroplane) Licence and had about 16,000 hours flying experience. They had been flying the E170 for about 3 years, and had accumulated about 2,500 hours on the type. They had flown to McArthur River Mine on many previous occasions.

The first officer operated the same flights as the captain on 9 and 10 January, and therefore had just over 9 hours free of duty before commencing on the day of the occurrence. They reported obtaining about 4 hours sleep during the night before the occurrence. The first officer recalled that they 'did not feel too bad' but that the crew were dissatisfied with the short break between duty periods.

The first officer did not conduct any duty from 4 to 6 January. During 7 to 9 January they conducted a morning duty period and then two afternoon–evening duty periods, accumulating 24.5 hours duty time and 16.5 hours flight time.

A review of training records noted frequent comments from check and training pilots advising the first officer to slow down when conducting checks and entering data into aircraft systems. The operator advised that the first officer had been provided with additional training to address these types of issues.

Flight management system

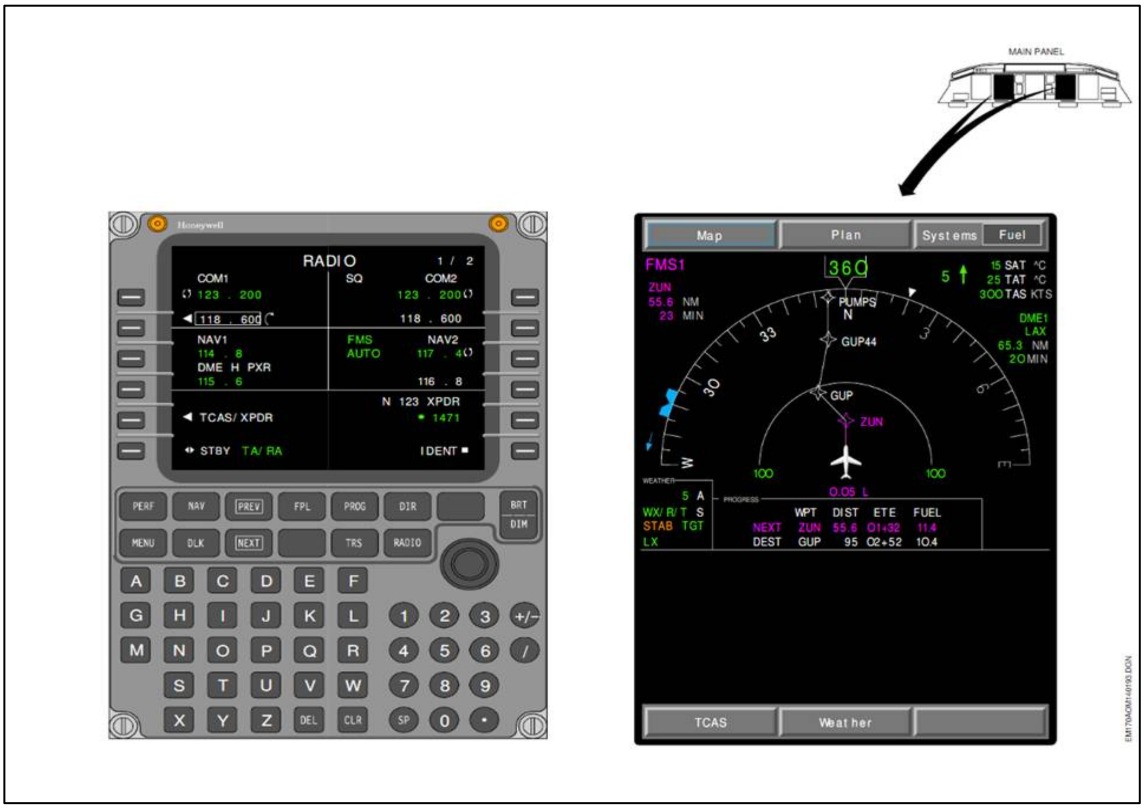
In the E170, a navigation plan is created and managed using the Flight Management System (FMS). Flight crews programme the FMS using the Multifunction Control Display Unit (MCDU), which is located in the flight deck centre pedestal (Figure 3). Manipulating the MCDU to create or amend an FMS flight plan involves making a number of sequenced keypad selections to retrieve information from the aircraft's navigation database, manipulate the information if required to define the required plan and then activate the plan.

Once crews amend an FMS flight plan using the MCDU, the proposed plan can be reviewed on the Navigation Display (ND), which presents a colour-coded representation of the plan on a map. The ND also provides a means of monitoring the position of the aircraft as a flight progresses.

The operator's procedures for using the FMS stated that it was the crew's responsibility to check all waypoints for correctness. This involved one pilot entering the data and the second pilot checking and verifying the data. FMS data input was included in the operator's aircraft conversion and re-current training.

The operator's procedures included a brief reference to the human factors issues associated with automation. Key statements drawing attention to the FMS included 'Any action to re-program the MCDU to keep the FMS up with changing flight paths that occurs during late stages of ground or flight operation will impact on safety'.

Figure 3: Examples of MCDU (left) and ND (right)



Source: Embraer

Other navigation aids

The aircraft was fitted with automatic direction finder (ADF)[7] equipment that was tuned to the McArthur River Mine non-directional beacon (NDB).[8] As the aircraft flew over SNOOD and began tracking to the IAF, the ADF would have indicated divergence from the direct track to McArthur River Mine of about 6°. However, due to the accuracy limitations of the ADF, and the fact that the aircraft was outside the published range of the NDB of 50 NM (93 km), the bearing pointer would not necessarily have provided a stable or salient indication of the diversion. The indication became more stable and salient as the aircraft neared the IAF.

Environmental factors

The crew noted that the flight to McArthur River was often challenging at that time of year due to thunderstorm activity. However, the flight on 10 January 2013 occurred in ideal conditions with clear skies and maximum visibility.

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7 Airborne radio navigation aid tuned to NDB or other suitable low frequency/medium frequency broadcast source.

8 A non-directional (radio) beacon (NDB) is a radio transmitter at a known location, used as a navigational aid. The signal transmitted does not include inherent directional information.

The crew reported that the workload during the flight was relatively low. They also noted that there were no distractions during the period associated with the occurrence.

Air traffic control

Airservices Australia was providing an ATC service to the aircraft from the time it departed Darwin. Its National Procedures Manual required controllers to obtain tracking intentions from the crew when an aircraft diverted from a previously approved or advised route.

The Australian Advanced Air Traffic System included a route adherence monitor (RAM) alert to detect when an aircraft was diverging from the approved route. The parameters for the alert were:

- a radius of 8 NM (15 km) from points
- a width of 15 NM (28 km) from published and unpublished corridors.

The flight crew's intention was queried by ATC at a point approximately 6 NM (11 km) left of track. This deviation did not meet the parameters for RAM activation. On this occasion, the call from ATC to the aircraft was undertaken as result of the controller's vigilance, which provided the necessary stimulus for the crew to later uncover the FMS data input error.

Safety Analysis

Introduction

Data input errors when programming a flight management system (FMS) are not uncommon (PARC/CAST Flight Deck Automation Working Group 2013), but they are usually detected by the flight crew before there is any effect on the aircraft's flight path or performance. On rare occasions programming errors can lead to problems with the aircraft's flight path or performance,[9] and on vary rare occasions such errors can contribute to aircraft accidents.[10]

Although data-entry error has the potential to become a hazard to flight safety, the risk associated with the navigation problem on the occurrence flight was minimal given there was no other traffic, there was no significant terrain in the vicinity of McArthur River Mine or on the incorrectly programmed route, the flight was conducted in visual conditions, and the crew were not experiencing any significant workload or other difficulties. In addition, the aircraft was fitted with an enhanced ground proximity warning system and a traffic collision avoidance system. Neither activated during the flight.

The navigation problem was promptly detected by air traffic control, and if this had not occurred it is likely that it would also have been detected by the crew as the aircraft neared the initial approach fix. Nevertheless, an analysis of the occurrence is useful in order to minimise the possibility of it occurring on other occasions where an erroneous flight path may be undertaken within proximity to more significant terrain or other hazards.

Data input error and error detection

The omission of the 25-NM waypoint when entering data into the Multifunctional Control Display Unit (MCDU) was almost certainly a skill-based error. Omitting a step in a task is one of the most common types of human error (Reason 2002). There was insufficient information to determine if the omission on this occasion was due to a slip (error of execution) or a lapse (error of memory).

A range of conditions may have increased the likelihood of the crew not initially detecting the data input error on this occasion. These included:

- The crew had flown the sector many times before without any similar problems, and probably had a high degree of expectancy that the programming task had been completed successfully.
- The crew's focus of attention was probably on the approach being used, which is something that can vary, rather than the 25-NM waypoint, which is always the same. Similarly, when the captain conducted the approach briefing, the focus appeared to be on the approach rather than the flight path to the start of the approach.
- The waypoint check when passing SNOOD was done soon after updating the FMS flight plan. This may have resulted in the crew having a high level of confidence at that time of the correctness of the waypoints. If there had been a longer delay before passing the next waypoint there may have been an increased level of vigilance associated with the waypoint check.

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9 For example, ATSB Research and Analysis Report AR-2009-052, *Take-off performance calculation and entry errors: A global perspective* reviews a series of occurrences where incorrect take-off weights were inputted into the FMS. Sarter and Alexander (2000) also note that problems with an aircraft's heading or course account for a significant proportion of incidents involving flight crew error.

10 For example, ATSB investigation AO-2011-102 (VFR flight into dark night involving Aérospatiale AS355F2 VH-NTV 145 km north of Marree, South Australia, 18 August 2011) probably involved the pilot incorrectly setting the fly-to point in a global positioning system (GPS) unit and then attempting to correct the situation during a high workload phase of flight.

- Research has shown that errors of omission are often difficult to detect by the people who make them (Sarter and Harrison 2000). In addition, the absence of something is more difficult to detect than the presence of something (Thomas and Wickens 2006). In other words, the absence of a waypoint would generally be more difficult to detect than the presence of an incorrect waypoint or an additional waypoint.
- There were no significant adverse weather or other operational hazards on the flight, which may have resulted in a reduced level of attention being directed to some routine tasks.

The diversion from the intended track as displayed by the automatic direction finder was probably not stable or salient, particularly at the time the aircraft passed SNOOD. A recent report into the operation of flight path management systems (PARC/CAST Flight Deck Automation Working Group 2013) noted that observational audits had identified that not completely complying with procedural requirements to cross-verify FMS entries is commonplace in line operations. The report stated:

> Simply put, it is easy to omit an onerous cross verification, or merely perform a perfunctory one when workload is high, time is short, or confidence is high and the likelihood of finding a mistake is low. However, this confidence is invalidated if an incorrect selection is made by the crew in the first place…

and that:

> Although there is general industry consensus that monitoring, cross verification, and error management are important, these topics are not always explicitly trained.

On the occurrence flight, high workload and distractions were not present at the time the data-input and checking errors were made. The operator's procedures for using the MCDU emphasised the importance of both crews checking that all waypoints have been entered correctly. Although the procedures did not outline in detail the specific actions the crew should use, the crew were both aware of the importance of doing the checks and the specific actions required.

Overall, the crew's errors highlight the importance of a systematic and comprehensive approach to checking the data entered into an FMS. Although the crew were conducting checks on this occasion, the checks were probably not systematic and comprehensive enough to identify the data input error.

Crew fatigue

The International Civil Aviation Organization (ICAO 2011) defined fatigue as:

> A physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member's alertness and ability to safely operate an aircraft or perform safety related duties.

Fatigue can have a range of adverse influences on human performance, such as slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance, and more lapses or errors of omission (Battelle Memorial Institute 1998). In addition, most people generally underestimate their level of fatigue.

Sleep is vital for recovery from fatigue, with both the quantity and quality of sleep being important. It is generally agreed that most people need at least 7–8 hours of sleep each day to achieve maximum levels of alertness and performance. A review of relevant research (Dawson and McCulloch 2005) concluded:

> …we can make broad assumptions from existing literature that obtaining less than 5 h [hours] sleep in the prior 24 h, and 12 h sleep in the prior 48 h would be inconsistent with a safe system of work.

Other research has indicated that less than 6 hours sleep in the previous 24 hours can increase risk. Thomas and Ferguson (2010) examined the effects of different amounts of sleep on the performance of Australian airline flight crews. The average amount of sleep in the previous 24 hours was 7.0 hours for the captains and 7.1 hours for the first officers. The occurrence of crew errors was higher, and performance at managing threats[11] was poorer, during flights when the crew included a captain with less than 6 hours sleep or a first officer with less than 5 hours sleep. Road safety research has also shown that the risk of a fatigue-related accident increases as the driver's amount of sleep in the previous 24 hours decreases, with several studies showing that less than 6 hours sleep has significantly more risk of an accident than 7-8 hours sleep (Williamson and others 2011).

Many studies have shown that early starts decrease the amount of sleep obtained. In general, it is difficult for people to successfully go to sleep earlier than normal. A recent study of Australian airline pilots found that their amount of sleep increased as the rostered start time became later, with an average of about 5.7 hours for a 0600 start (Roach and others 2012). Self-reported levels of fatigue were also higher with early starts.

In the case of the occurrence flight, the first officer had 4 hours sleep during the night prior to the occurrence. The captain had about 5 hours sleep. However, the quality of the captain's sleep had been affected and they were feeling tired, indicating that the sleep had not been sufficiently restorative. Accordingly, it is reasonable to conclude that both crew were probably experiencing a level of fatigue known to have at least a mild to moderate effect on performance. Factors such as time awake, time of day and workload were unlikely to have exacerbated this level of fatigue.

The types of errors made by the crew, in terms of an error of omission and then not detecting the error, even when alerted to the problem by air traffic control, are consistent with the effects of fatigue. However, the context at the time of the error (as discussed in Data input error and error detection) was also more conducive than normal to the development and non-detection of such errors. Therefore, it is difficult to conclude that fatigue actually contributed to the crew's errors on this occasion.

Fatigue management

The operator managed its flight crews' flight and duty times to comply with a standard industry exemption to Civil Aviation Order (CAO) 48, which was issued to the operator by the Civil Aviation Safety Authority (CASA). The operator's rostering personnel also managed flight and duty times in order to comply with the relevant industrial agreement and, where possible, personal preferences of flight crew members. The operator did not have and was not required to have a fatigue risk management system (FRMS).

The CAO 48 exemption imposed a number of conditions on crews' flight and duty times. With regard to 'time free of duty' for domestic high-capacity operations, the exemption stated that if the previous duty period did not exceed 12 hours, the time free of duty had to be 10 hours or more. However, if the previous duty period did not exceed 10 hours and the time free of duty included the period from 2200 to 0600, then the time free of duty could be reduced to 9 hours. This was the situation that applied to the flight crew of VH-ANO on 9 and 10 January 2013.

In recent years, aviation regulatory authorities around the world have recognised the need for time free of duty periods to provide an 8-hour sleep opportunity, and that to do so requires a minimum period of at least 10 hours. In addition, many regulatory authorities, including CASA, have recognised that time free of duty periods at home base will require longer durations to allow flight crew sufficient time for commuting and meeting their social obligations.

It is widely acknowledged that minimising fatigue is a responsibility for both flight crews and operators, and that crews should ensure they use the rest periods provided to them to obtain adequate sleep where possible. However, to allow a flight crew to commute to and from an airport, deal with a range of personal requirements, and allow for an adequate sleep opportunity is very

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[11] The Thomas and Ferguson paper stated that 'Effective threat management involves the crew detecting in a timely manner an operational threat, such as an aircraft system malfunction, and ensuring that the threat does not lead to any operational risk.'

difficult with only 9 hours time off duty. In the case of the occurrence flight, a longer time free of duty would have provided the crew more opportunity to obtain adequate sleep prior to starting duty on the 10 January. Rostering both pilots for the same duty periods on 9 and 10 January with limited time free of duty also increased the fatigue risk associated with the operation.

The operator stated that, at the time of the occurrence, it had some roster patterns that involved 9 to 9.5-hour overnight rest periods, but that individual pilots did not conduct such rosters on a frequent basis. It also stated that, in the period leading up to the occurrence, the number of available crew for its three E170 aircraft was less than desirable, which placed some constraints on its ability to manage rosters. The operator also noted that for the roster pattern involved in the occurrence flight, the duty period following the approximately 9.2-hour break between 9 and 10 January was relatively short and that commuting times were generally not significant for its Darwin-based pilots.

The operator stated that its pilots could self-report fatigue through its integrated reporting system. In such cases, the pilot would be removed from operational duty and provided with sufficient rest, and the pilot's previous rosters would be analysed. It noted that there had been no pilot reports of fatigue in the 12 months prior to the end of November 2013. Pilots confirmed that it was possible to report concerns about fatigue or rosters, but they perceived that the general view from management and rostering personnel was that if a roster met the legal requirements then it was considered safe.

The operator stated that its rosters were not routinely evaluated by any bio-mathematical model of fatigue or assessed by human factors specialists. In reviewing the occurrence flight crew's rosters, the ATSB noted that the operator's flight crews conducted a significant number of early starts (duty periods commencing between 0430 and 0600), early starts on multiple successive days and some early starts involving duty periods of up to 12 hours. These rostering practices did not breach the requirements of the CAO 48 exemption. However, early starts are widely recognised as a potentially significant fatigue risk requiring management, and Roach and others (2012) have recommended that short-haul operators using duty periods with early starts should implement an FRMS with multiple, redundant defences against fatigue risk.

The requirements outlined in the CAO 48 exemption were minimum standards, and flight crew operating within flight and duty time limits can still be subject to fatigue. ICAO (2011) noted that:

> The traditional regulatory approach to managing crewmember fatigue has been to prescribe limits on maximum daily, monthly, and yearly flight and duty hours, and require minimum breaks within and between duty periods…
>
> Prescriptive flight and duty time limits represent a somewhat simplistic view of safety – being inside the limits is safe while being outside the limits is unsafe – and they represent a single defensive strategy. While they are adequate for some types of operations, they are a one-size-fits-all approach that does not take into account operational differences or differences among crewmembers.
>
> In contrast, an FRMS employs multi-layered defensive strategies to manage fatigue-related risks regardless of their source. It includes data-driven, ongoing adaptive processes that can identify fatigue hazards and then develop, implement and evaluate controls and mitigation strategies. These include both organizational and personal mitigation strategies.

In summary, the operator's rostering practices were consistent with the regulatory requirements at the time, and there were some additional mitigators in place to minimise fatigue risk. However, the operator had limited processes in place to proactively manage its flight crew rosters and ensure that fatigue risk due to restricted sleep was effectively minimised.

Findings

From the evidence available, the following findings are made with respect to the navigation event that occurred 125 NM (232 km) north-west of McArthur River Mine involving an Embraer E170 aircraft, registered VH-ANO. They should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- When programming the flight management system for the descent and approach, the crew omitted a waypoint and their crosschecking processes were not effective in detecting the omission.

Other factors that increased risk

- Due to restricted sleep in the previous 24 hours, the crew were probably experiencing a level of fatigue known to have a demonstrated effect on performance.
- **Although the operator's rostering practices were consistent with the existing regulatory requirements, it had limited processes in place to proactively manage its flight crew rosters and ensure that fatigue risk due to restricted sleep was effectively minimised. [Safety issue]**

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

Depending on the level of risk of the safety issue, the extent of corrective action taken by the relevant organisation, or the desirability of directing a broad safety message to the aviation industry, the ATSB may issue safety recommendations or safety advisory notices as part of the final report.

Fatigue management

Number:	AO-2013-010-SI-01
Issue owner:	Airnorth
Operation affected:	Aviation: Air transport
Who it affects:	The operator's flight crews

Safety issue description:

Although the operator's rostering practices were consistent with the existing regulatory requirements, it had limited processes in place to proactively manage its flight crew rosters and ensure that fatigue risk due to restricted sleep was effectively minimised.

Proactive safety action taken by Airnorth:

Action number: AO-2013-010-NSA-007

Airnorth advised that, since the time of the occurrence, it had increased its E170 flight crew by about 30 per cent. This increase had resulted in flight crews doing less flight hours and providing more flexibility in rostering the flight crews.

In addition, Airnorth advised that due to changes in schedules, its rostering patterns had changed so that there were no longer any planned rosters that required overnight free of duty periods of less than 10 hours. Occasionally there were actual overnight free of duty periods less than 10 hours when the day's duty period was extended for operational reasons, but these were relatively rare.

Proactive safety action taken by the Civil Aviation Safety Authority:

Action number: AO-2013-010-NSA-008

Although not in response to this occurrence, on 28 March 2013 the Civil Aviation Safety Authority (CASA) released revised fatigue management and flight and duty time requirements in Civil Aviation Order (CAO) 48.1 Instrument 2013. These requirements were to take effect for existing operators on 30 April 2016.

The revised CAO 48.1 stated that, for air transport operations, an operator had to comply with a set of limits and requirements (dependent on the type of operation) or operate to a fatigue risk management system (FRMS), if that FRMS was approved by CASA.

If an operator was not using a CASA-approved FRMS, CAO 48.1 stated that a flight crew member (FCM) must not be assigned or commence a flight duty period at home base unless, within the 12 hours immediately before commencing the duty period, they had at least 8 hours consecutive sleep opportunity. For a duty period commencing away from home base, the 8-hours sleep opportunity must be provided within the previous 10 hours. Sleep opportunity was defined as:

> a period of time during an off-duty period when an FCM:
>
> (a) is not meeting the reasonable requirements of bodily functioning such as eating, drinking, toileting, washing and dressing; and
>
> (b) has access to suitable sleeping accommodation without, under normal circumstances, being interrupted by any requirement of the AOC [Air Operator's Certificate] holder.

Compared to the previous standard industry exemption to CAO 48, the revised CAO 48.1 also provided more restrictions regarding the length of duty periods associated with early starts.

Current status of the safety issue:

Issue status: Adequately addressed

Justification: The ATSB is satisfied that the changes made by the operator, and the increased requirements relating to fatigue management being imposed by the regulator, will reduce the risk associated with this safety issue.

Other safety action by Airnorth

Airnorth advised that it had provided additional guidance in its operating procedures that placed further emphasis on the importance and associated considerations concerned with data entry into the flight management system (FMS) and the management of FMS navigation.

General details

Occurrence details

Date and time:	10 January 2013 – 0737 CST	
Occurrence category:	Incident	
Primary occurrence type:	Navigation event	
Location:	125 NM (232 km) north-west of McArthur River Mine, Northern Territory	
	Latitude: 14° 50' 60" S	Longitude: 134° 41' 13" E

Aircraft details

Manufacturer and model:	Embraer E170	
Registration:	VH-ANO	
Operator:	Airnorth	
Serial number:	17000099	
Type of operation:	Air transport - high capacity	
Persons on board:	Crew – 4	Passengers – 23
Injuries:	Crew – nil	Passengers – nil
Damage:	Nil	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the flight crew
- Airnorth
- Airservices Australia (Airservices).

References

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Williamson, A Lombardi, DA Folkard, S Stutts, J Courtney, TK & Connor, JL 2011, 'The link between fatigue and safety', *Accident Analysis and Prevention*, vol. 43, pp. 498-515.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the flight crew, Airnorth, the Civil Aviation Safety Authority (CASA) and Airservices. Submissions were received from Airnorth and CASA. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

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10 January 2013

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